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RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced GCE **4772**

Decision Mathematics 2

Mark Scheme for June 2010

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1.

(a)(i) $\sim c \Rightarrow e$	B1
(ii) $\quad (c \Rightarrow \sim e) \Leftrightarrow (\sim c \Rightarrow e)$ $\qquad$ 1 0 01 0 $\quad$ 01 1 1 $\quad$ or $\quad$ 0 1 10 0 $\quad$ 10 0 0	M1 $\quad$ line of a TT A1 $\quad$ both propositions $\qquad\qquad$ 1 or both 0 M1 $\quad$ an "$\Rightarrow$" correct A1 $\quad$ all OK
(b)(i) Circuit is $\sim x \vee y$. This is $x \Rightarrow y$. $\qquad\qquad$ 10 1 0 $\qquad$ 0 1 0 $\qquad\qquad$ 10 1 1 $\qquad$ 0 1 1 $\qquad\qquad$ 01 0 0 $\qquad$ 1 0 0 $\qquad\qquad$ 01 1 1 $\qquad$ 1 1 1	B1 B4
(ii) $(\sim p \wedge \sim q) \Rightarrow r$	M1 $\quad$ implication noted A1
(iii) $(\sim p \wedge \sim q) \Rightarrow r$ is equivalent to $\sim r \Rightarrow \sim(\sim p \wedge \sim q)$	B1
But we have $\sim r$, so we have $\sim(\sim p \wedge \sim q)$.	B1
$\sim(\sim p \wedge \sim q)$ is equivalent to $p \vee q$	B1
But we have $\sim q$, so therefore p.	B1

2.

| (i) | Distances longer | B1 |

(ii)

	1	2	3	4	5	6			1	2	3	4	5	6
1	∞	15	∞	∞	7	8		**1**	1	2	3	4	5	6
2	15	∞	6	2	6	∞		**2**	1	2	3	4	5	6
3	∞	6	∞	3	∞	∞		**3**	1	2	3	4	5	6
4	∞	2	3	∞	10	17		**4**	1	2	3	4	5	6
5	7	6	∞	10	∞	8		**5**	1	2	3	4	5	6
6	8	∞	∞	17	8	∞		**6**	1	2	3	4	5	6

not part of answer

	1	2	3	4	5	6			1	2	3	4	5	6
1	∞	15	∞	∞	7	8		**1**	1	2	3	4	5	6
2	15	30	6	2	6	23		**2**	1	1	3	4	5	1
3	∞	6	∞	3	∞	∞		**3**	1	2	3	4	5	6
4	∞	2	3	∞	10	17		**4**	1	2	3	4	5	6
5	7	6	∞	10	14	8		**5**	1	2	3	4	1	6
6	8	23	∞	17	8	16		**6**	1	1	3	4	5	1

not part of answer

	1	2	3	4	5	6			1	2	3	4	5	6
1	30	15	21	17	7	8		**1**	2	2	2	2	5	6
2	15	30	6	2	6	23		**2**	1	1	3	4	5	1
3	21	6	12	3	12	29		**3**	2	2	2	4	2	2
4	17	2	3	4	8	17		**4**	2	2	3	2	2	6
5	7	6	12	8	12	8		**5**	1	2	2	2	2	6
6	8	23	29	17	8	16		**6**	1	1	1	4	5	1

M1 30 in top left
A1 times
A1 6 to 3 route = 1
A1 rest of route

	1	2	3	4	5	6			1	2	3	4	5	6
1	30	15	21	17	7	8		**1**	2	2	2	2	5	6
2	15	12	6	2	6	23		**2**	1	3	3	4	5	1
3	21	6	12	3	12	29		**3**	2	2	2	4	2	2
4	17	2	3	4	8	17		**4**	2	2	3	2	2	6
5	7	6	12	8	12	8		**5**	1	2	2	2	2	6
6	8	23	29	17	8	16		**6**	1	1	1	4	5	1

not part of answer

	1	2	3	4	5	6			1	2	3	4	5	6
1	30	15	20	17	7	8		**1**	2	2	2	2	5	6
2	15	4	5	2	6	19		**2**	1	4	4	4	5	4
3	20	5	6	3	11	20		**3**	4	4	4	4	4	4
4	17	2	3	4	8	17		**4**	2	2	3	2	2	6
5	7	6	11	8	12	8		**5**	1	2	2	2	2	6
6	8	19	20	17	8	16		**6**	1	4	4	4	5	1

not part of answer

	1	2	3	4	5	6			1	2	3	4	5	6
1	14	13	18	15	7	8		**1**	5	5	5	5	5	6
2	13	4	5	2	6	14		**2**	5	4	4	4	5	5
3	18	5	6	3	11	19		**3**	4	4	4	4	4	4
4	15	2	3	4	8	16		**4**	2	2	3	2	2	2
5	7	6	11	8	12	8		**5**	1	2	2	2	2	6
6	8	14	19	16	8	16		**6**	1	5	5	5	5	1

not part of answer

	1	2	3	4	5	6			1	2	3	4	5	6
1	14	13	18	15	7	8		**1**	5	5	5	5	5	6
2	13	4	5	2	6	14		**2**	5	4	4	4	5	5
3	18	5	6	3	11	19		**3**	4	4	4	4	4	4
4	15	2	3	4	8	16		**4**	2	2	3	2	2	2
5	7	6	11	8	12	8		**5**	1	2	2	2	2	6
6	8	14	19	16	8	16		**6**	1	5	5	5	5	1

not part of answer

(iii) cont		
	It has found all shortest times and corresponding routes.	B1 B1
	Shortest time from x to y is in x row and y column of time matrix.	
	For route look in x row and y column of route matrix. This gives first vertex "en route". Repeat, looking in row corresponding to the current "en route" vertex and the y column, until the "en route" vertex is y.	B1
	Shortest time from 3 to 6 is 19.	B1
	Corresponding route is 3 to 4 to 2 to 5 to 6.	B1
(iv)	On time matrix – 1(7)5(6)2(2)4(3)3(19)6(8)1 so 45	B1
	From route matrix – 1 5 2 4 3 4 2 5 6 1	B1
(v)	Lower bound = 7 + 8 + 19 = 34	M1
		A1 7 + 8
		A1 19
(vi)	82 + 8 = 90 minutes	B1

4772   Mark Scheme   June 2010

3.

(i) & (ii)

11*(35*50/80 + 25)
= 515.625

11*(35*50/80)
= 240.625

50+10*(36*50/80 + 25)
= 525

50+10*36*50/80
= 275

6*50+5*(41*50/80 + 25)
= 553.125

6*50+5*41*50/80
= 428.125

405.625 — p/t 0.6 / ~p/t 0.4

459.375 — R59 / R60 / R65

400 — p/t 0.5 / ~p/t 0.5

459.375 — p/t 0.25 / ~p/t 0.75

Retire at 65, EMV = 459375

M1   3-way split
A1   choice node

M1   2-way splits
A1   chance nodes

B1   pension calculations
M1   (income + pension)
      × time
A1   retire at 59
A1   retire at 60
A1   retire at 65

M1   EMV's
A1√

M1   choice
A1√

(iii)   p's (in order) $\frac{1}{2}$ 0 $\frac{6}{11}$ $\frac{1}{11}$ $\frac{17}{22}$ (given) $\frac{6}{11}$ M1   A1

Retire at 59.
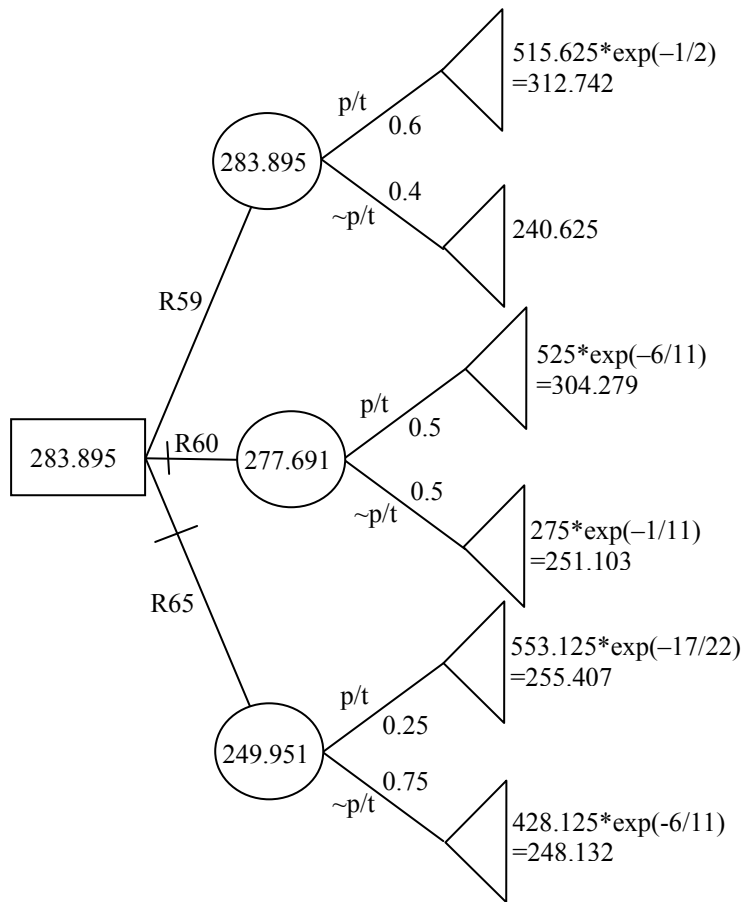
M1   final utilites
A1   cao

M1   expecteds
A1   √

B1   choice

4.

(i)   Max $180x + 90y + 110z$ B1

       st $2x + 5y + 3z \leq 30$ B1

                  $4x + \ y + 2z \leq 24$ B1

(ii)

P	x	y	z	s1	s2	RHS	
1	–180	–90	–110	0	0	0	M1 initial tableau
0	2	5	3	1	0	30	A1
0	4	1	2	0	1	24	
1	0	–45	–20	0	45	1080	M1 first iteration
0	0	4.5	2	1	–0.5	18	A1
0	1	0.25	0.5	0	0.25	6	
1	0	0	0	10	40	1260	M1 second iteration
0	0	1	4/9	2/9	–1/9	4	A1
0	1	0	7/18	–1/18	5/18	5	

     Identification of basic variables + values   B1 B1

(iii)   Over two weeks (x = 3 and z = 18)   B1

(iv)   Degeneracy (technical term not required) – objective   B1   same obj value

       planes are parallel to boundary line.   B1   line of solutions

(v)

A	P	x	y	z	s1	s2	s3	s4	a	RHS
1	0	1	1	0	0	0	0	–1	0	7
0	1	–180	–90	–110	0	0	0	0	0	0
0	0	2	5	3	1	0	0	0	0	30
0	0	4	1	2	0	1	0	0	0	24
0	0	1	1	0	0	0	1	0	0	7
0	0	1	1	0	0	0	0	–1	1	7

     B1   = → ≤ + ≥

     B1   ≤ row

     B1   ≥ row

     B1   new objective

     B1   minimise A

     or

     or

P	x	y	z	s1	s2	s3	s4	a	RHS
1	–M–180	–M–90	–110	0	0		M	0	–7M
0	2	5	3	1	0	0	0	0	30
0	4	1	2	0	1	0	0	0	24
0	1	1	0	0	0	1	0	0	7
0	1	1	0	0	0	0	–1	1	7

     B1   = → ≤ + ≥

     B1   ≤ row

     B1   ≥ row

     B1   new objective

     B1   maximise P

(vi)   Point is on the line – gives £1260 profit   B1   (either)

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